

# Biodiversity & Conservation

1) Species of ants <sup>more than</sup> 20,000

2) Species of Beetles - 3,00,000

3) Species of fishes - 28,000

4) Species of orchids - 20,000 <sup>nearly</sup>

\* Scientists working  $\rightarrow$  **Ecologists**  
 $\rightarrow$  **Evolutionary Biologists**

Life originated on earth  $\approx$  3.8 billion yrs ago (bya)

**Biodiversity**  $\rightarrow$  In our Biosphere  $\rightarrow$  Immense diversity [or heterogeneity]

All levels of Biol. Organ. also

species level exist at

Term - **Biodiversity**

to describe

popularised by (not coined)

Socio biologist - **Edward Wilson**

Combined diversity at all the levels of  $\rightarrow$  occurs within a species

Biological Organisation

components of biodiversity

**Genetic diversity**

**Species diversity**

**Ecological diversity**

Single species might show high diversity (within species) at Genetic level

Diversity at species level

At  $\rightarrow$  ecosystem level

over its **Distributional Range**

Example

India  $\gg$  Norway (scandinavian country) ecosystem diversity

Genetic Variation shown by Rauwolfia Vomitoria (medicinal plant)

**Western Ghats**

have greater

India has  $\rightarrow$  Deserts

Himalayan ranges growing in might be in terms of Potency Concentration

amphibian species diversity

- Rain forests
- Mangroves
- Coral reefs
- Wetlands
- Estuaries
- Alpine meadows

**Eastern Ghats**

Produced by plants active chemicals (Reserpine)

India has

Takes million of years of evolution  $\rightarrow$  to accumulate Rich diversity in nature

Genetically diff strains of **RICE**

Varieties of mango **mango** 1000

We can Lose all the wealth.

But

< 2 centuries

Present rates of species losses continue

> 50,000 more than



# How Many Species are there on Earth & How Many In INDIA

Acc to → International Union for Conservation of Nature & Natural Resources (IUCN), 2004.

Slightly more than 1.5 million

Total no. of plants & animal species

\* For many Taxonomic Groups → species inventories more complete in

Tropical countries than Temperate

\* Considering → overwhelmingly of species waiting to be discovered are in large proportion

Temperate - tropical species richness of statistical comparison Biologists make a Tropics

of exhaustively studied group of Insects → extrapolate this ratio to other groups

Total no. of species on earth

Gross estimate of

to come up with

animal plants

Some extreme estimates range 20 to 50 million

\* Note → Conservative Scientifically → sound estimate made by Robert May

7 million at Global diversity place

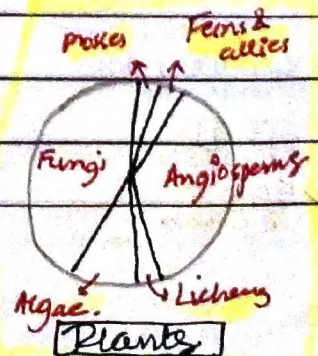
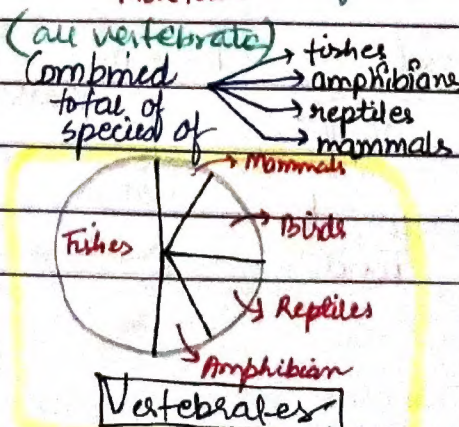
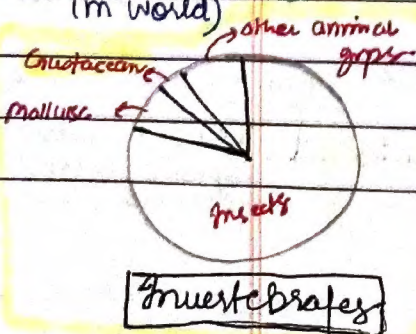
\* > 70% of all species are animals

not more than

\* Plants (algae, fungi, Bryophyte, Gymnosperm, Angiosperm) are 22%

\* Among animals, Insects → Most species-rich taxonomic group → 70% of Total → 7/10 → insects animals

\* No of Fungi species (in world)





These estimates do not give any figures for Prokaryotes

Biologists not sure about how many prok. species might be there

Conventional Taxonomic Method  $\leftarrow$  is Problem  $\leftarrow$

are not suitable for identifying microbial species many species ] not culturable under laboratory conditions

If we accept  $\leftarrow$  Biochemical criteria } for delineating species of this group  
 $\leftarrow$  Molecular criteria

millions might run into their diversity alone

India has  $\rightarrow$  2.4% of (world's land area)

share in Global species diversity is impressive  $\rightarrow$  8.1%

this makes

Our country

45,000 plant species

2 x 45,000 animal species

1 of 12 mega diversity countries of world

recorded from India

\* If we accept  $\rightarrow$  May's Global Estimate then Only 22% of total species have been recorded so far

> 1,00,000 plant species  
more than > 3,00,000 animal species

then there are India  $\leftarrow$  applying this in

yet to be discovered & described

\* Immense manpower (taxonomists) Time required to complete inventory of Biological wealth of our country

Large fraction of these species faces the threat of becoming extinct even before discovering them  $\leftarrow$  this becomes more hopeless

"Nature Biological Library is burning before we catalogued the files of all Books stocked there"

TANISHA SACHAN

AIR 1747



# Patterns of Biodiversity

## (i) Latitudinal Gradients

- Diversity of  $\left\{ \begin{array}{l} \text{plants} \\ \text{animals} \end{array} \right\} \rightarrow$  ~~uniform~~ throughout the world. but shows uneven distribution
- many groups of  $\left\{ \begin{array}{l} \text{animals} \\ \text{plants} \end{array} \right\} \rightarrow$  there are  $\rightarrow$  interesting patterns in diversity most well known

\* Species diversity -  $\downarrow$  moving from equator to poles. Latitudinal Gradient in Diversity

With very few exceptions, TROPICS - latitudinal range  $23.5^\circ \text{N} - 23.5^\circ \text{S}$   
 $\downarrow$  harbour more species than  $\rightarrow$  temperate areas  
 $\rightarrow$  polar areas

Colombia - near equator  $\rightarrow$  has nearly 1400 species birds

New York -  $41^\circ \text{N}$   $\rightarrow$  has 105 sp. birds

Greenland -  $71^\circ \text{N}$   $\rightarrow$  has 56 sp. birds

India - much of its land in tropical latitudes  $\rightarrow$  > 1200 sp. birds  
more than

\* A Forest in tropical region like Equador  $\rightarrow$  has 10X as many species of vascular plants

\* Largely tropical

Amazonian Rain forest  
(In: South America)

Forest of equal area in temperate region as in

Example  $\rightarrow$  Midwest of USA

has

Greatest Biodiversity on earth

home to

<u>plants</u> $\downarrow$ maximum <u>&gt; 40,000 sp</u>	<u>Fishes</u> $\downarrow$ 3000 sp	<u>Birds</u> $\downarrow$ 1300 sp	<u>427 sp</u> $\downarrow$ $\left\{ \begin{array}{l} \text{amphibians} \\ \text{mammals} \end{array} \right.$	<u>Reptiles</u> $\downarrow$ <u>1378</u>	<u>Invertebrate</u> $\downarrow$ more than <u>&gt; 1,25,000</u>
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Scientists estimate  $\rightarrow$  in these Rain forest

There might be  $\rightarrow$  at least 2 million insect species

waiting to be discovered and named.

Why tropics - Greater diversity?



Ecologists  
Evolutionary Biologists

proposed various hypothesis → some important

## Speciation

is generally  
function of time

unlike temp. regions  
subjected to frequent  
glaciation in past.

Tropical latitudes have  
remained relatively  
undisturbed for  
million of years.

thus had  
long evolutionary time  
for  
species diversification

Tropical environments  
unlike temperate ones

less seasonal  
relatively more constant  
& predictable

Such constant environments

promote  
niche specialisation

lead to  
↑↑ species diversity

Tropics have

↑↑ solar energy  
available

contributes to

Higher productivity

this in turn might  
contribute to indirectly

Greater diversity

## ii) Species - Area Relationship

Great German Naturalist  
(Geographer)

ALEXANDER VON HUMBOLDT

Wilderness of South  
American jungles

in during his pioneering  
& extensive exploration

observed that within a region → species richness increased with increasing explored area

Relation b/w species richness & area (but only up to a limit)  
for wide variety of taxa

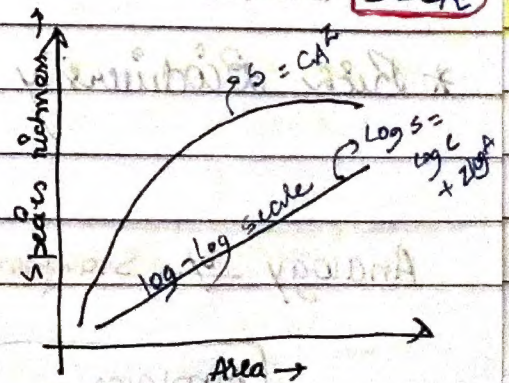
angiosp. plants, Birds, Bats, Fresh water fish

turns to be Rectangular hyperbola  
 $S = CA^Z$

\* On Logarithmic scale, relationship is a straight line

$$\log S = \log C + Z \log A$$

S = species richness  
A = area  
Z = slope of line (regression co-efficient)  
C = y-intercept





Ecologists have discovered  $\rightarrow$  value of  $z$   $\xrightarrow{\text{lies in}}$  0.1 to 0.2  $\xrightarrow{\text{regardless of}}$  Taxonomic group

slope of regression line  $\rightarrow$  [plants in Britain, Birds in California, Molluscs in New York]  $\rightarrow$  whether its a [Region]

$\rightarrow$  amazingly similar

\* If you analyze  $\rightarrow$  species area relationships  $\xrightarrow{\text{among}}$  very large areas (like continents)

much steeper  $\leftarrow$  to be slope of the line  $\leftarrow$  you will find

$z$  values in range of 0.6 to 1.2

\* Example  $\rightarrow$  Frugivores (fruit eating) birds, Mammals  $\rightarrow$  in Tropical forests of different continents

1.25  $\leftarrow$  slope is found

## \* The Importance Of Species Diversity to the Ecosystem

\* For many decades  $\rightarrow$  Ecologists believed  $\rightarrow$  Communities with more species than those with less species  $\rightarrow$  tend to be more stable  $\leftarrow$  generally

A stable community  $\rightarrow$  (1) Too much variation in productivity year to year.

(2) Resistant / Resilient to occasional disturbance  $\rightarrow$  natural / man-made

~~(3) Resistant to invasion by~~  $\rightarrow$  alien species

## David Tilman's Long term Ecosystem Experiments

using outdoor plots

found that plots with more species showed less year to year variation  $\rightarrow$  in total biomass

also showed  $\rightarrow$   $\uparrow\uparrow$  diversity contributed to higher productivity

\* Rich Biodiversity  $\xrightarrow{\text{essential for}}$  Ecosystem health  $\xrightarrow{\text{imperative for}}$  Survival of human race on this planet.

Analogy by  $\rightarrow$  Stanford Ecologist Paul Ehrlich  $\rightarrow$  RIVET POPPER HYPOTHESIS

Airplane - ecosystem

Rivets - species



In an airplane (ecosystem)  $\xrightarrow{\text{all parts joined by}}$  1000s of rivets (species)  $\xrightarrow{\text{if every passenger travelling}}$  popping a rivet  $\xrightarrow{\text{starts}}$  take home  $\xrightarrow{\text{to}}$  (causing species to become extinct)  $\xrightarrow{\text{it may not affect}}$  Flight safety (proper functioning of ecosystem)  $\xrightarrow{\text{but}}$  as more and more rivets removed  $\xrightarrow{\text{plane become}}$  dangerously weak  $\xrightarrow{\text{over period of time}}$  which rivet removed may also be critical  $\xrightarrow{\text{furthermore}}$  Loss of rivets on wings  $\xrightarrow{\text{is obviously}}$  more serious threat to flight safety (key species that drive major ecosystem function)  $\xrightarrow{\text{than}}$  Loss of few rivets on seats/windows inside plane.

# Loss Of Biodiversity

Declining Biological wealth  $\xrightarrow{\text{accusation to}}$  Human activities

\* Colonisation of Tropical Pacific Islands by humans  $\xrightarrow{\text{more than led}}$  Extinction of 2000 species Native Birds

\* IUCN Red List, 2004 in last 500 yrs

Documents extinction of 784 species (in summary too)  $\rightarrow$  338 vertebrates, 359 invertebrates, 87 plants

\* Some RECENT EXTINCTIONS include

Dodo	Quaga	Thylacine	Steller's Sea Cow	Subspecies of Tiger
$\downarrow$ Mauritius	$\downarrow$ Africa	$\downarrow$ Australia	$\downarrow$ Russia	$\downarrow$ Bali, Javan, Caspian

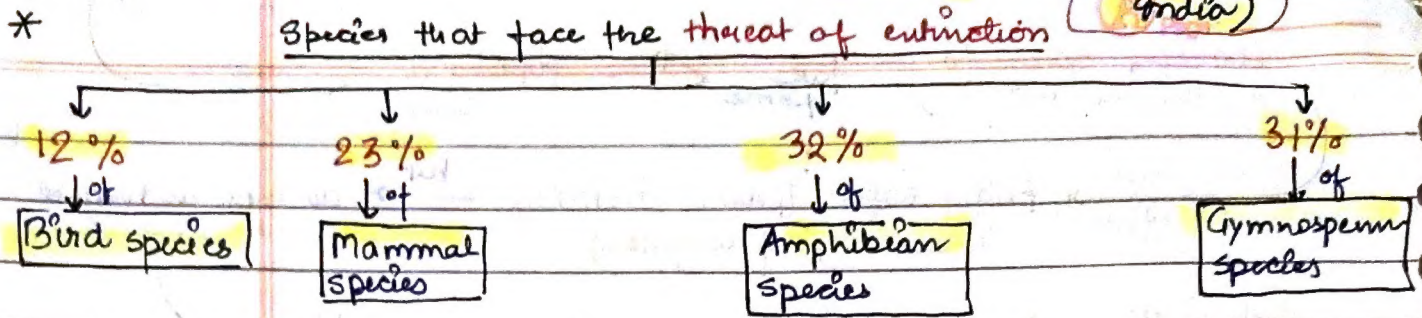
\* Last 20 yrs alone witnessed disappearance of 27 species

\* Careful analysis  $\rightarrow$  records show extinction across taxa random

some amphibian groups more vulnerable to extinctions



- Species facing the threat of extinction are  $\rightarrow$  15,500 species worldwide  $\rightarrow$  more than  $\rightarrow$  ( $> 650$  from India)



\* From a study of history of life on earth through Fossil Records we learn that Large-scale loss of species (one we are currently witnessing) have also happened earlier.

Humans appeared even before

\* During the long period since origin of life on earth ( $> 3$  billion years) diversification

5 episodes of "mass extinction of species" (one we are currently witnessing)

6th extinction

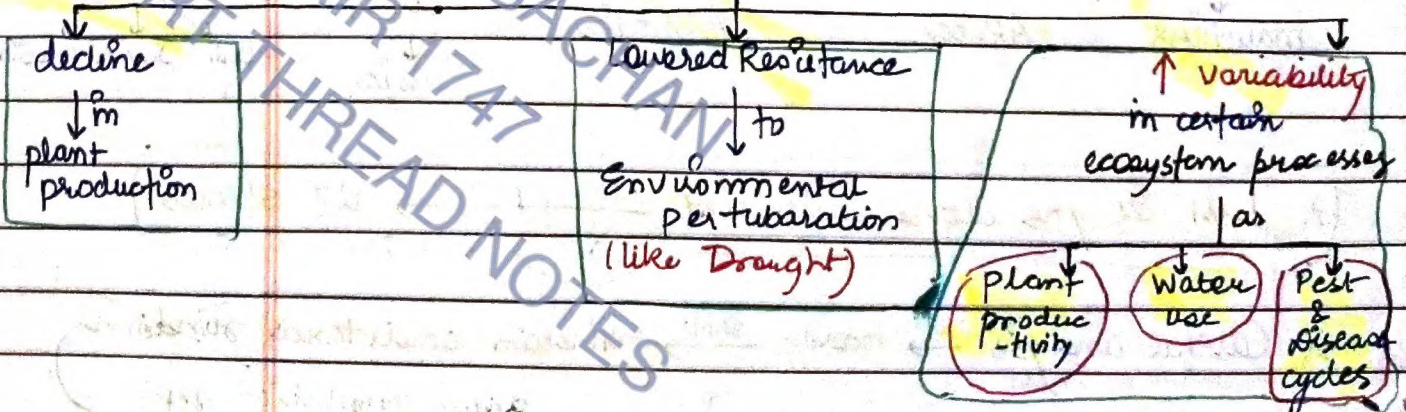
Rates - 100 to 1000 times faster than Pre human times

our activities responsible for faster rates

Ecologists warn if present trends continue  $\rightarrow$  half of all species on earth

100 yrs  $\rightarrow$  wiped out within

(Loss of Biodiversity) may lead to





# Cause Of Biodiversity Losses → accelerated species loss / extinction due to human activities.

## The Evil Quartet

### Co-extinction

When species extincts  
 ↓  
 plant & species associated animal  
 obligatory way with it  
 → also become extinct  
 e.g. unique assemblage of parasite also extincts.  
 Another example  
 ↓  
 Coevolved plant pollinator mutualism  
 → where extinction of one invariably leads to extinction of other

### Alien species invasion

Alien species introduced (unintentionally or deliberately) for any purpose.  
 (some of them) → turns invasive  
 ↓  
 decline → cause of extinction  
 \* Nile perch in Lake victoria (in East Africa)  
 (led eventually to extinction of ecologically unique assemblage)  
 > 200 species of cichlid fish in lake.  
 Threat of native species by invasive weed species like  
 Lantana (Mimosa)  
 Water hyacinth (Eichhornia)  
 Illegal introduction of African Catfish  
 → threat to indigenous catfish in our rivers.  
 purpose to export

### Over-exploitation

Humans depends on natural food shelter for when 'need' hunt to "graze"  
 ↓  
 leads to over exploitation of natural resources  
 many species extinctions in 500 yrs  
 Last 500 yrs  
 ↓  
 steller's sea cow  
 Passenger Pigeon  
 were due to overexploitation by humans  
 PRESENTLY → Many marine fishes population around world harvested  
 → endangering continued existence of some commercially imp. species

### Habitat Loss & Fragmentation

Most imp cause for extinction of animals  
 • Most dramatic Example comes from Tropical Rain Forests  
 Once covered 14% of earth's land surface most near  
 ↓  
 Now cover < 6% being destroyed fast  
 By the time you finish reading this chap, 1000 more hectares of Rain forest would be lost  
 \* Amazonia Rain SO "lungs of the planet"  
 → harbours millions of species  
 being cut & cleared  
 → cultivating soyabean  
 → conversion to Grassland (to raise beef / cattle)  
 Besides total loss, degradation of many habitat by pollution  
 → threatens survival of many species  
 Large habitats broken into small fragments  
 → various human activities due to  
 affects  
 → Mammals, Birds acquiring large territories  
 → certain crim. etc with migratory habitat

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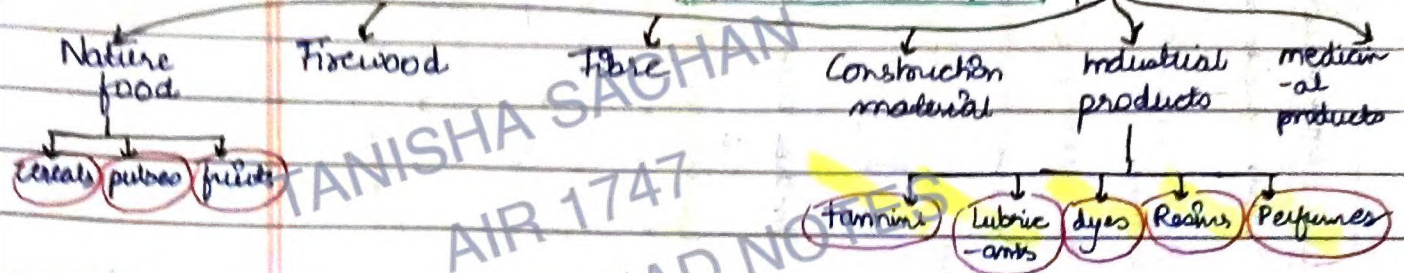


# Biodiversity Conservation

Why should we conserve Biodiversity? 3 reasons, some obvious, some not, but all important.

## (i) (NARROWLY UTILITARIAN) obvious arguments

- Humans derive countless direct economic benefits from



- > 25% of drugs currently sold in market worldwide derived from plants

Traditional medicines contribute to 25000 species of plants  
 (used by) → Native peoples around the world

Nobody knows → how many more medicinal plant there are in Tropical Rain Forest

\* Increasing resource put into BIOPROSPECTING (waiting to be explored)

exploring → molecular scientific species → biodiversity for products of economic importance (not ecological)

\* Nations endowed with rich biodiversity can expect to reap enormous benefits

## (ii) (BROADLY UTILITARIAN) arguments says biodiversity plays major role in many ecosystem services that nature provides

\* Amazon Rain forest expected to produce 20% of Total oxygen in atmosphere through photosynthesis

\* Pollination provided by ecosystem through Pollination layer. Bees, Bumblebees, Birds, Bats

\* Aesthetic pleasures of Walking through woods, Spring flower watching, Wake up to Bulbuls song

## (iii) (ETHICAL) arguments concerning Biodiversity relate to what we owe to millions of

Philosophically Spiritually → we need to realise every species have (intrinsic value)  
 even if it not be of economic value → Moral duty to pass bio-legacy to next gen.



# How do we conserve Biodiversity?

## In-situ

We → conserve  
→ protect } whole ecosystem  
Biodiversity → its  
at all levels  
is protected

We save entire forest  
tigers ← to save

## On site conservation

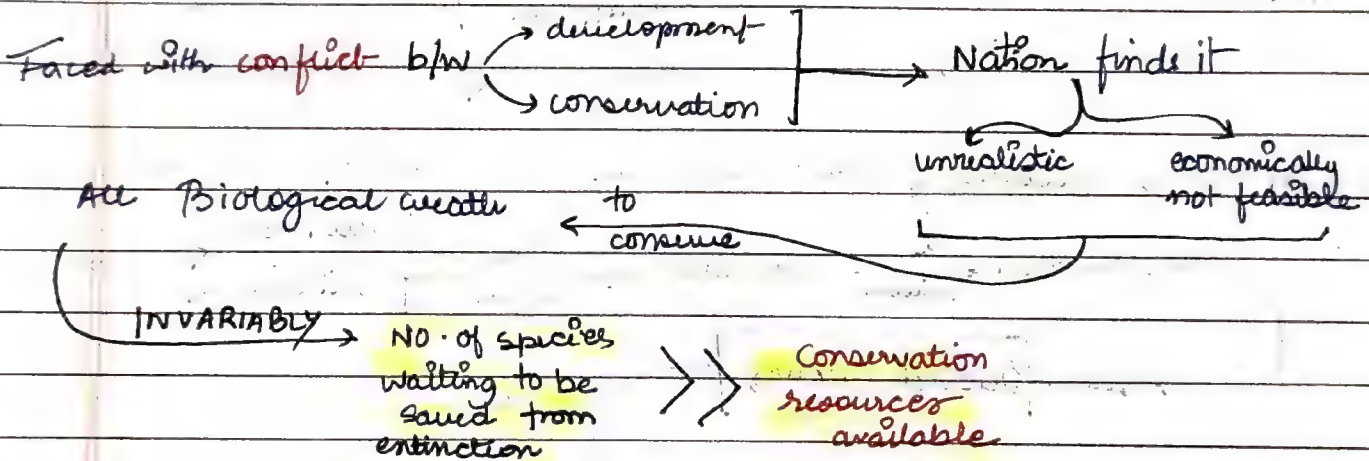
## Ex-situ

IF → animal } → endangered  
→ plant } → threatened  
organism facing very high  
risk of extinction in world.  
in near future.

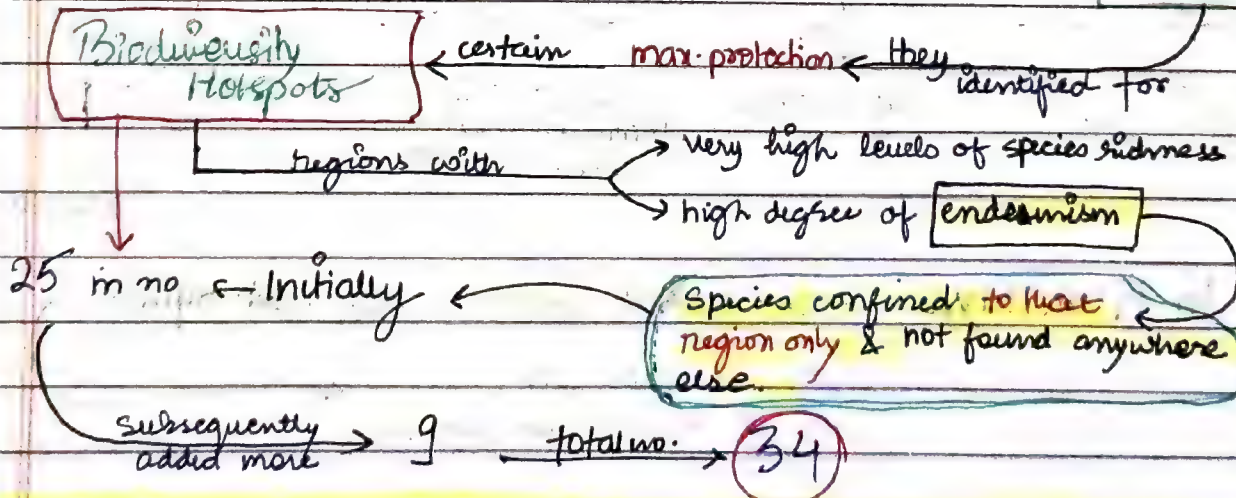
needs  
urgent measures to save it  
from extinction.

## Off site conservation

# In-Situ Conservation



\* On global basis → this problem has been addressed by → eminent conservationist



\* These Hotspots → regions of accelerated habitat loss.

3 of these hotspots  
cover India's exceptionally  
high Biodiversity regions

Western ghats - Sri Lanka  
Indo-Burma  
& Himalayas.



All Biodiversity hotspots put together cover.

cover

< 2% of earth's land area.  
less than

\* These hotspots → no of species collectively is extremely high

30%

by

Ongoing mass extinction

could reduce

strict protection of these hotspots

In INDIA, ecologically unique & biodiversity-rich regions

Biosphere reserves

National parks

Sanctuaries

legally protected

are

\* INDIA

has

Biosphere reserves — 14

National parks — 90

Wildlife sanctuaries — 448 (in summary — >450)

India

has

History of

religious & cultural

traditions

Protection of nature

that emphasised

In many cultures, tracts of forest

were set aside

Total protection

& given

venerated

within were

all trees

wildlife

Such Sacred Groves

are found in

Khasi & Jaintia Hills

Aravalli Hills

Western Ghats regions of

Sarguja

Chandaul

in

in

of

Bastar

of

Meghalaya

Rajasthan

Karnataka

Maharashtra

Madhya Pradesh

\* In Meghalaya → Sacred groves are last refuges

large numbers of rare & threatened plants

for

## Ex-Situ Conservation

In this approach, threatened Plants & Animals

special setting

placed in

taken out from their natural habitat

are



where they can be → protected & given special care.

Zoological parks

Botanical Garden

Wildlife Safari Parks

\* There are many animals that have become extinct in wild

Zoological parks ← but continue to be maintained in

\* In recent years, Ex-situ conservation

Keeping threatened species in enclosures. ← has advanced beyond

Now gametes of threatened species

long periods for viable fertile cond. can be preserved

using cryopreservation techniques

\* Eggs can be fertilised in vitro

\* Planks can be propagated using Tissue culture methods

\* Seeds of different Genetic Strains of commercially important plants

Long periods in Seed Banks ← can be kept for



Biodiversity  $\xrightarrow{\text{knows}}$  No ~~political~~ ~~Boundaries~~

$\xrightarrow{\text{its conservation}}$  collective responsibility of all nations

\* Historic Convention  $\xrightarrow{\text{on}}$  Biological Diversity

$\xrightarrow{\text{held in}}$  "The Earth Summit"

Rio de Janeiro  
(in 1992)

$\xrightarrow{\text{called upon all nations to take}}$

appropriate measures

Biodiversity

$\leftarrow$  of

Sustainable Development

$\xrightarrow{\text{of its}}$  benefits

\* World Summit on Sustainable Development

$\downarrow$  in

2002 Johannesburg South Africa

190 countries

pledged their commitment to achieve by 2010

a significant reductions

$\downarrow$  in

current rate of Biodiversity of Loss

of

Global

Regional

Local



\* Calculate approximate no. of insect species in unit area having 98545 total Species Diversity

70% of  $\uparrow$   
are animals = 5981

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4187 = 70% of  
are insects  $\uparrow$